

# STAINLESS STEELS

*and their uses*



STAINLESS STEELS RESIST CORROSION

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# STAINLESS STEELS

*and their uses*



STAINLESS STEELS RESIST CORROSION

**ELECTRO METALLURGICAL COMPANY**

*Unit of Union Carbide and Carbon Corporation*



Carbide and Carbon Building • 30 East 42nd Street, New York 17, N. Y.

*In Canada:* Electro Metallurgical Company of Canada, Ltd., Welland, Ont.

Stainless steels, because of their widespread use and popularity, are undoubtedly the best known of all alloy steels. Beautiful, durable, and resistant to the effects of heat and corrosion, they are suitable for use in almost every industrial field. Indeed, new uses are being developed so rapidly that it is frequently difficult to keep abreast of them.

The superior physical properties of stainless steels have made possible tremendous advances in engineering. Their greater strength and endurance have enabled engineers to reduce the weight of transportation equipment and machine parts, at the same time increasing the factor of safety. In the chemical and process industries stainless steels have greatly reduced the enormous losses caused by oxidation and corrosion since they resist the action of most chemicals. Stainless steel used in food equipment helps to assure an uncontaminated product.

This booklet has been prepared in the belief that a brief summary of some of these major applications of stainless steel will be of great interest to a large number of people. Electro Metallurgical Company is not itself a producer of steels or alloy steels, but, as the manufacturer of "Electromet" ferro-alloys, which are used by makers of all kinds of steels, the company has acquired a vast fund of technical data. This information, backed by engineering experience and complete metallurgical facilities, is available without prejudice to all manufacturers, fabricators and users of alloy steels.

#### ELECTRO METALLURGICAL COMPANY

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# Stainless Steels And Their Uses

## **Chromium-Alloy Steels Are Employed in Practically Every Industrial Field**

**S**TAINLESS steels do not rust, corrode, or tarnish under ordinary conditions of use. They are stainless because they contain chromium. At least 11 per cent chromium is necessary to make steel stainless; usually, the higher the chromium content the more resistant the steel becomes, until, for the extreme conditions exemplified by high-temperature service in chemical plants, the steel may require as much as 30 per cent chromium. Even if steel contains only 4 to 6 per cent chromium it will be moderately resistant to atmospheric conditions since it acquires an adherent rust, which serves as a form of protection.

While chromium must always be present in stainless steels, other alloying metals are frequently included to make the characteristics of the final steel most adaptable for its intended use. Second to chromium in importance in stainless steel is nickel, and, in fact, the most generally used stainless steels at the present time are those that contain from 17 to 20 per cent chromium and 7 to 10 per cent nickel. All stainless steels contain manganese and silicon and, for specific purposes, some contain such elements as tungsten, molybdenum, columbium, and nitrogen, each of which enhances some particular characteristic. Tungsten confers hardness, molybdenum gives resistance to certain chemicals, columbium improves corrosion resistance in welded structures, and nitrogen increases strength without loss of ductility.

Stainless steels owe much of their popularity to the fact that they do not tarnish or rust, but they have other advantages as well. They can be polished to a mirror-like smoothness and brightness. The finished surface does not scratch easily. They cannot chip or peel, and their valuable properties of strength and corrosion resistance are the same throughout the metal.

*The splendor of the Empire State Building in New York City is enhanced by trim of 18-8 chrome-nickel steel.*





With all these valuable attributes, stainless steels bring to the arts and sciences a versatile material—whether for artistic purposes or for the almost limitless utilitarian applications where a long-lasting metal is needed.

In general there are three metallurgical classifications of stainless steels. The first classification (ferritic) is not hardenable by heat-treatment. It can, however, be drawn and formed into many simple shapes. It is particularly suited for chemical plant equipment handling nitric acid and has also been employed for automotive trim. The second class (martensitic) is readily hardened and strengthened by heat-treatment. Careful treatment and polishing are advisable to develop its corrosion-resisting properties most completely. It is most generally used for high-grade cutlery and for machinery parts that require the combination of high strength with corrosion resistance. The third group of stainless steels (austenitic) includes the highly versatile steels, which are tough and ductile, and which may be cold-rolled or drawn to develop high strength and at the same time retain good forming and welding properties. The chromium-nickel alloy steels, of which the well-known "18-8" is typical, belong to this third group.

These steels have become increasingly important in this country, until at the present time applications for this metal have been found in

practically every industry. Stainless steels are particularly well adapted for use in resisting atmospheric corrosion, attack from oxidizing agents, and scaling at elevated temperatures. Progressive designers are continually finding new uses for stainless steels in place of ordinary steel and cast iron because of their high physical properties and broad range corrosion resistance.

The consumption of stainless steels in various fields has grown tremendously as the merits of these alloys have been appreciated and applied. A survey of the major consumers shows that the petroleum, chemical, architectural, food preparation and distribution, paper, hospital, aviation, transportation, and marine fields are all major users of stainless and other high-chromium steels.

The ready adaptability of the stainless chromium-nickel steels to the food and associated industries has brought about a very rapid advancement in this field, and the petroleum, automotive, and chemical industries also continue to find new applications for them. Through the 1930's stainless steel became increasingly important in high-temperature and pressure work, in shipbuilding and architecture. More recent large-scale consumers include the aircraft, hospital, railroad, textile, and paper fields.

A survey of the particular uses of stainless steels in these major fields is extremely interesting because of the diversity of applications shown.

*This kitchen is completely equipped throughout with 18-8 chrome-nickel steel, thus insuring beauty and cleanliness at all times.*







*Milk bottle filling machine head made entirely of 18-8 chrome-nickel steel.*

#### FOOD INDUSTRY

Under this heading are included the equipment and containers used in the preparation, packing, and distribution of foods, and the household culinary appliances which have recently become so popular.

Probably the largest application in this field is the use of stainless steel containers. Ranging in size from small cans to tanks for trucks and freight cars, these containers are rapidly becoming increasingly valuable in the shipping of milk, fruit juices, beverages, and all foods that have a tendency to corrode the materials formerly used, or that are affected by contact with ordinary metals.

Equipment used in preparing various foods has shown greatly improved performance when stainless steel has been used for parts subject to rusting or corrosion. Beaters, mixers, paddles, vats, and drums found in bakeries, candy factories, bottling works,

are being fabricated to a large extent from 18-8 chrome-nickel steel.

A partial list of the stainless steel equipment used in the dairy branch of the food industry follows:

Circulating-type horizontal vat pasteurizers:

All linings and jackets

Spray pasteurizers:

All linings and jackets

Continuous pasteurizers:

All linings and jackets

Paddle-type pasteurizers:

Linings, jackets and paddles

Tank compartments for milk trucks

Tank compartments for freight cars

Automatic milk holders:

Compartments and jackets

Cylindrical storage tank linings

*These large stainless steel kettles are part of equipment used in canning cranberries.*



Air-actuated holders

Homogenizers:

Pistons, cylinders, suction valve seats, discharge valve seats, valve rods

Condensers

Vacuum pans



Steam chests for condensing vacuum pans

Sterilizers

Revolving vertical coil vats

Surface coolers:

Tubing, headers, and fins

Internal ammonia coolers

Weighing tanks and cans

Dump tanks

Bottle fillers:

All sheet metal and tubes in contact with milk

Pipe line filters

Ice boxes

Valves and fittings of all kinds

Ice cream cabinets, linings and covers

Tables

Butter boxes for butter printers

Recording thermometers:

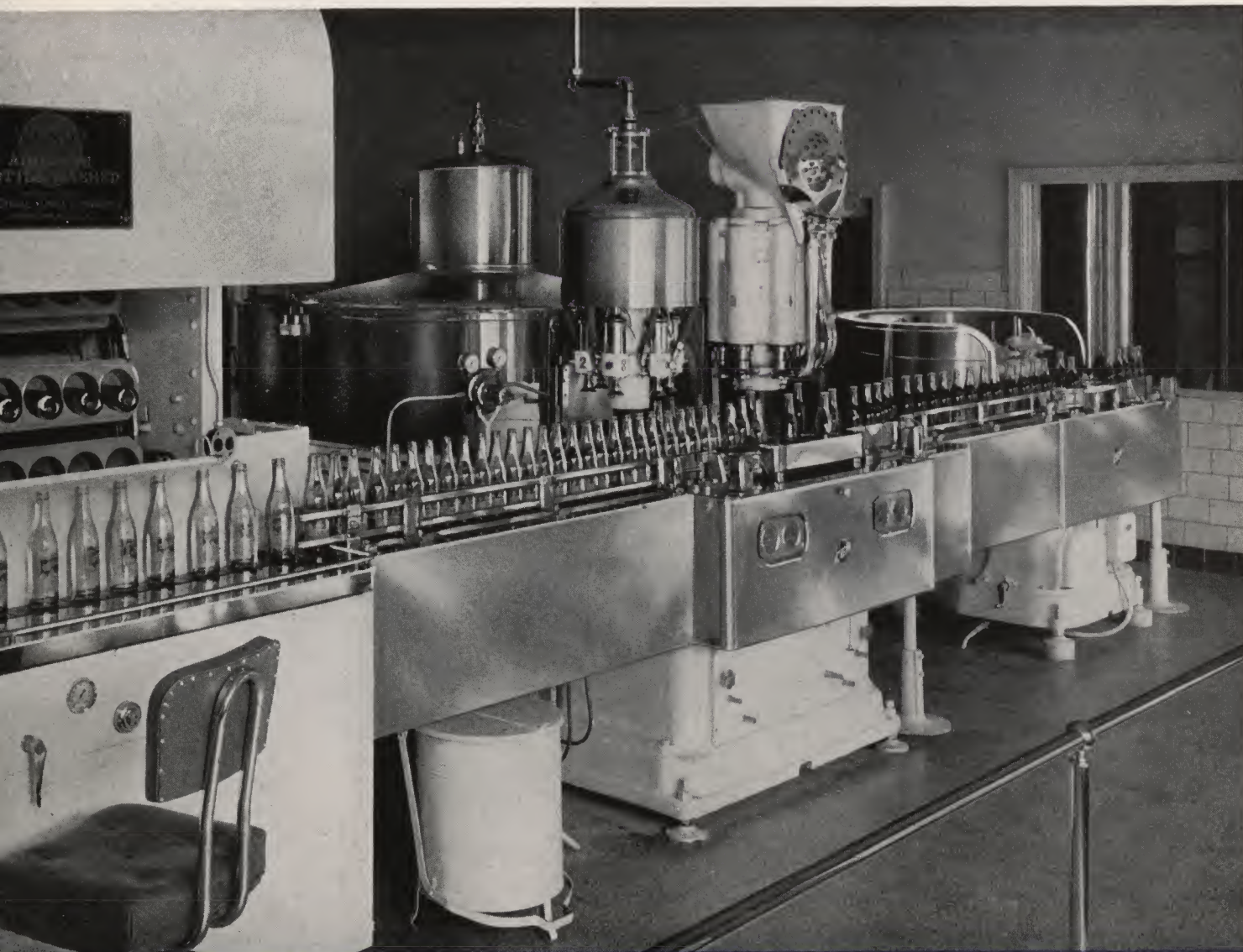
All metal parts coming in contact with the milk

This list might be considered typical of the uses to be found in other branches of the food industry. Wherever fruit juices, fatty acids, or foods come in contact with metal, stainless steel will be found to be particularly advantageous.

Stainless steels have been widely used for fruit knives, corrugated rolls for crushing machines, canning equipment such as dippers, pails, vats, pipe lines, cookers, and conveyors.

Bakeries use chrome-nickel steel for dough mixers, troughs, baking pans, spoons and dippers.

*In this modern bottling plant, the production machinery, which is equipped with stainless steel parts, has a clean and sparkling appearance.*





*Stainless sinks of 18-8 chrome-nickel steel add beauty and cleanliness to any pantry or kitchen.*



*Stainless steel tableware can easily be cleaned and retains its spotless beauty permanently.*



*Stainless steel kitchen utensils will not rust or tarnish and are not affected by food acids.*





A considerable amount of this material is used in equipment of packing houses, where metal parts come in contact with animal fats and acids and consequently are subject to corrosion.

Probably one of the most popular uses of stainless steel is in kitchens, particularly those of restaurants, hotels and hospitals. A few of the applications are listed below:

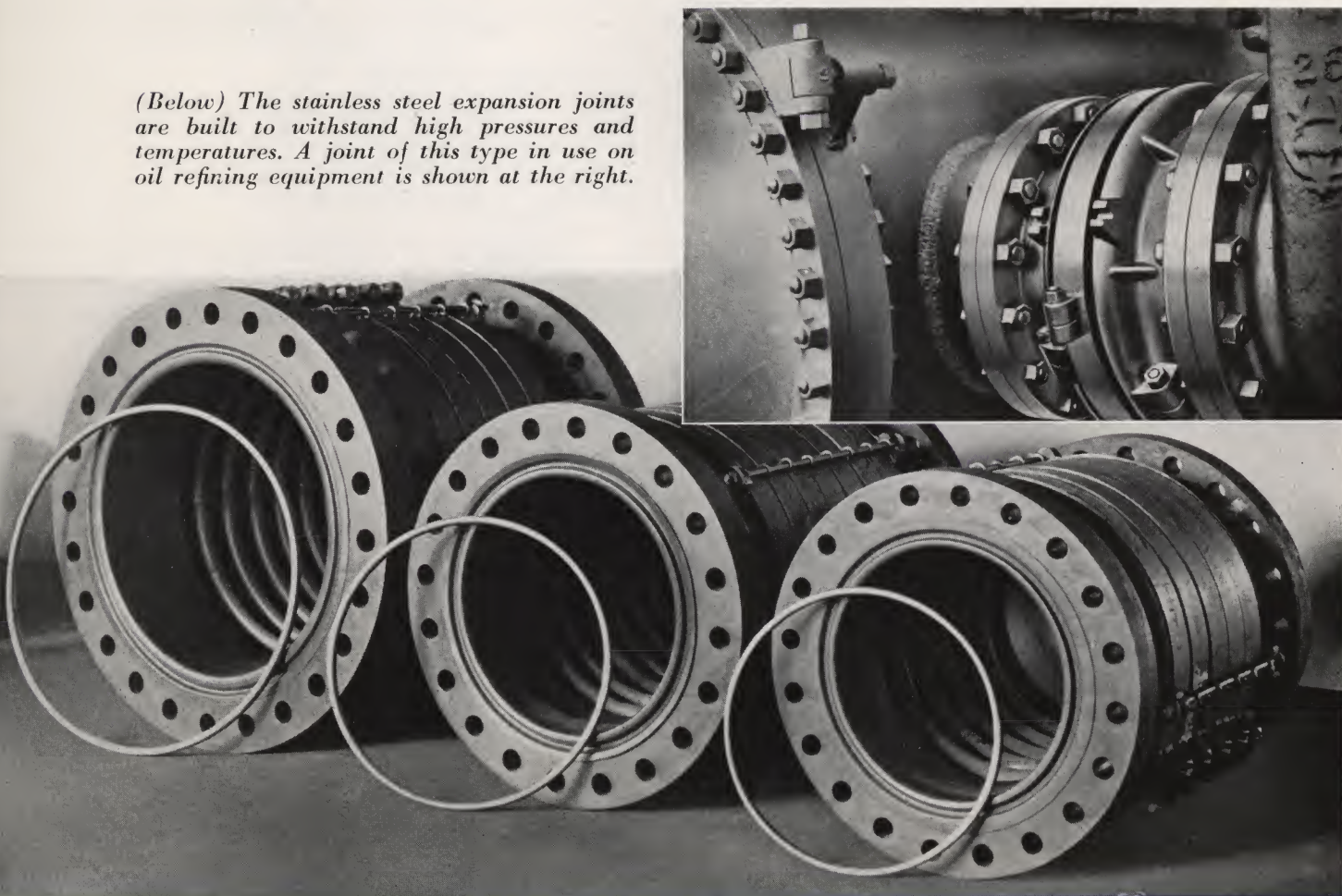
- Stationary and tilting kettles
- Steamer and roaster parts
- Boilers and cookers
- Practically every kind of cooking utensil
- Slicing machines
- Milk and cream dispensers
- Dish and glass washing equipment
- Cook's tables
- Steam tables
- Warmers
- Plate covers and trays
- Counters
- Hand rails
- Cutlery
- Refrigerator and stove trim
- Covers for commercial mayonnaise mixers
- Ice containers for shipping fish

### PETROLEUM INDUSTRY

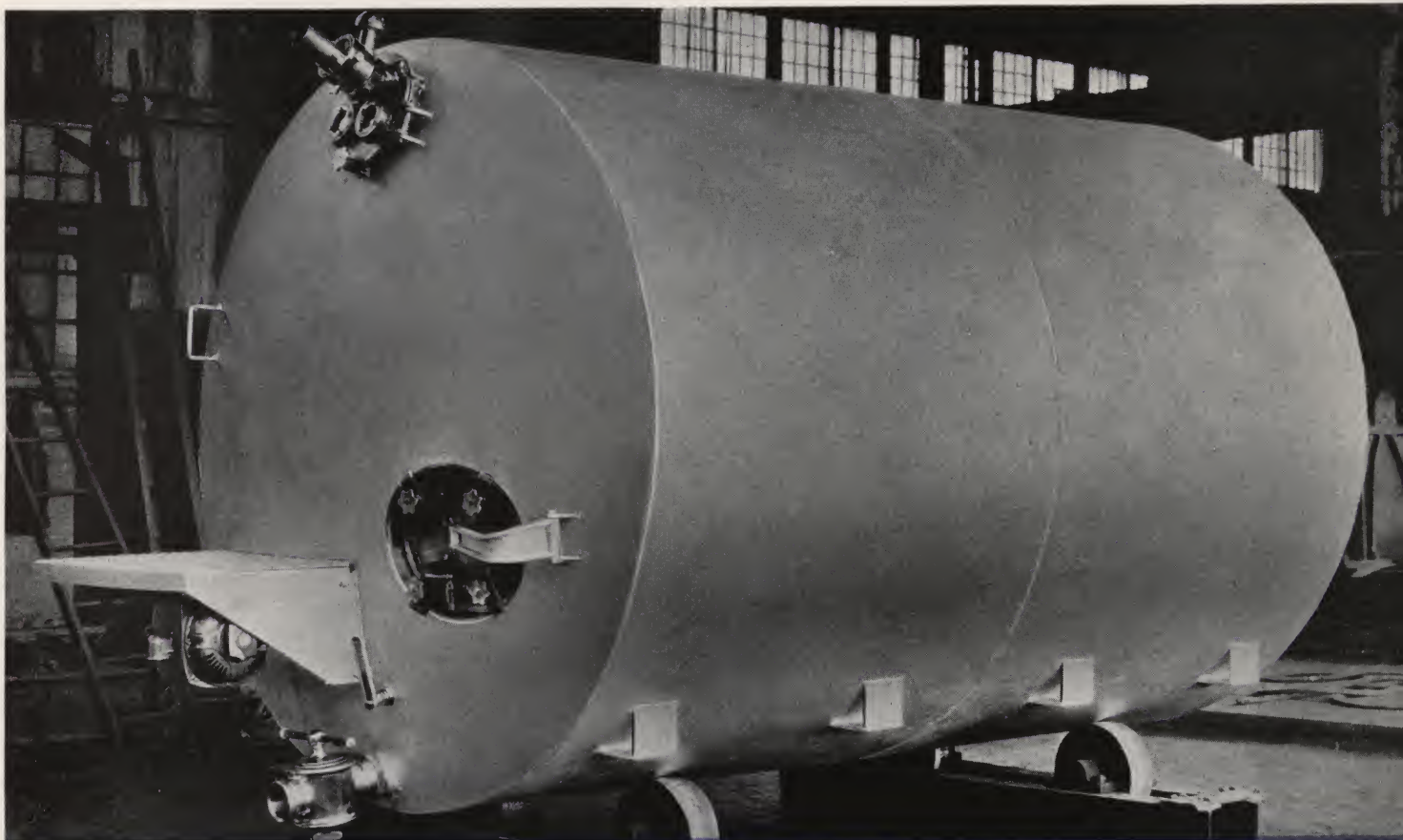
The extremely corrosive agents encountered in the petroleum industry attack metals so rapidly that the life of ordinary steels is frequently very short. The cracking and refining operation is so severe in its effects that plain carbon steel tubing lasts only a few months — frequently only a few hours. Various types of alloy steel have been tried, and at the present time the stainless steels have shown the best results. In some instances, where crude oil has a high sulphur content, a high-chromium steel that is low in nickel may prove the most suitable. Where great strength and heat resistance are desired, the chrome-nickel steels give the best results. Some of the more important applications of the stainless steels in this field are as follows:

- Oil still tubes, valves and fittings
- Tube supports, hangers and sheets
- Header boxes and return bends
- Bubble caps and plates
- Swing lines in sour crude oil storage tanks

*(Below) The stainless steel expansion joints are built to withstand high pressures and temperatures. A joint of this type in use on oil refining equipment is shown at the right.*







*The stainless steel lining of this 3,000-gal. milk storage tank insures clean, sanitary equipment.*

*Gas—laden with mercury vapor—is passed into this condenser system at a quicksilver mine. The tubing is fabricated of a molybdenum-bearing variety of stainless steel.*







*Many applications for stainless steel equipment have been found in laundries.*

Tower linings  
Pump parts, pipe fittings, and stop cocks  
Hot oil pumps:  
Valves, nuts and bolts, wet-end pistons  
Ball valves and valve seats  
Air preheaters

### AUTOMOTIVE INDUSTRY

The major use of stainless steels in the automotive industry is for trim that will not rust or tarnish. They are also used to a large extent for certain parts, such as pump shafts, that are subject to corrosion. Stainless steel meets these requirements perfectly since it is easy to keep clean and bright. In addition, its deep drawing and forming properties make it a suitable material from the point of view of the manufacturer. Some of the uses of stainless steel for automobiles are given below:

Radiator shells

Head lamps  
Bumpers  
Fenders  
Hub caps and wheel spokes  
Door hinges and handles  
Cowl lamps, beading and stop lights  
Dashboard trim  
Curtain glass frames  
Gasoline tank caps and radiator caps  
Pump shafts

### CHEMICAL INDUSTRY

The greatest need in the chemical industry is for a corrosion-resistant metal suitable for use in equipment coming into contact with highly active chemicals. As yet, no single alloy has been developed that will meet all requirements, but stainless steels have gone far in meeting the situation. An extensive field for these steels has been opened up by their great resistance to attack from nitric acid



and other powerful oxidizing agents. Innumerable pieces of apparatus and equipment parts are fabricated from stainless steels; but the accompanying list may be considered typical:

## Nitric acid equipment:

- Pipe lines, vats, valves, towers, drums, and tank cars
- Pails and nozzles for handling sulphuric acid
- Pickling tanks
- Acid tanks of many types
- Retorts
- Condensers
- Stills
- Digestors
- Evaporators
- Heat exchangers
- Autoclaves
- Coils, piping, valves, seats, and fittings
- Mill liner-plates
- Pump rods, plungers, shafts, casings, etc.
- Conveyor shafts
- Agitator blades
- Filter screen

## HIGH TEMPERATURE AND PRESSURE

Stainless steels are notably resistant to high-temperature oxidation. Experiments have shown that a thin adherent film containing chromium oxide is formed on the surface of the metal, which retards further oxidation to a marked degree. This desirable property of stainless steel opens up a vast field for its use as heat-resisting parts.

Long-time tests have indicated high creep-strengths at elevated temperatures. This is a most important feature of any metal subjected to high stresses at elevated temperatures, and it has resulted in an increasing use of these steels for equipment operating under highly adverse conditions. The following applications have found favor where high temperatures and pressures are required:

- Furnace flue valves
- Furnace door arches
- Vapor condensers
- Return bends
- Heat exchangers
- Absorption towers

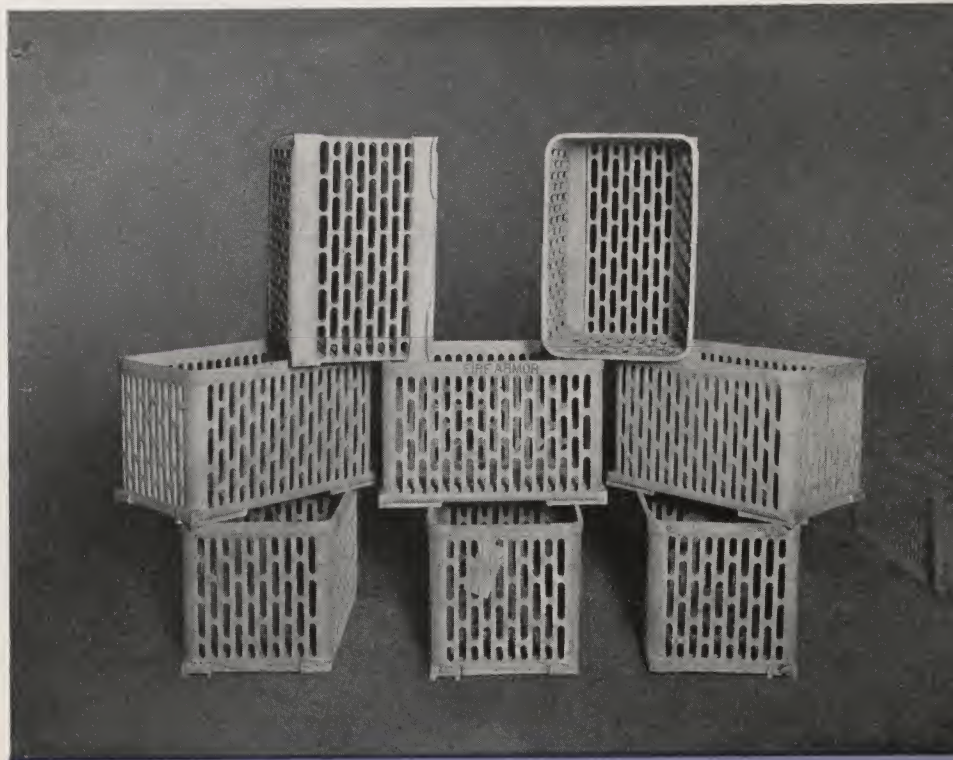
## Autoclaves

- Furnace plates, spiders and retorts
- Checkerwork supports for blast furnace stoves
- Oil burner nozzles, fire-pots, and combustion bowls
- Retorts
- Annealing boxes
- Calcining retorts
- Lead and cyanide dipping baskets
- Enameling bucks, racks and hangers
- Glass rolls
- Normalizing furnace rolls
- Conveyor links
- Skid rails for billet heating furnaces
- Smelter bins
- Blower fans
- High-temperature and high-pressure bombs
- Instantaneous water-heater coils
- Piping, valves and fittings of all types
- Rabble arms for roasting furnaces

## MARINE

Potential applications in the marine industry are numerous, and progress is being made in introducing stainless steels for fittings and parts sub-

*The chromium content of these annealing boxes combats oxidation at high temperatures.*





jected to the action of sea water. Great resistance to salt air, spray, and immersion in sea water renders them particularly well adapted to the bright-work and rigging about a ship, and one of the largest uses of stainless steel wire rope is for yacht rigging. The durability of stainless steel justifies its use for parts more or less continuously immersed in salt water, notably in cables and superstructure used on submarines. The following may be considered representative uses in this field:

Passenger and cargo ships:

- Deck fixtures
- Galley trim
- Pantry, dresser and table tops

*Stainless steel is used for work tables and dressers in the culinary department of many steamships.*

- Barber shop trim
- Cabin fittings
- Marine hardware
- Door panels
- Fireplaces
- Hand rails
- Riggings
- Landing floats

Motor boats and small craft:

- Outboard motor parts
- Fender strips and wales
- Cutwaters
- Chocks, cleats, etc.
- Windshield brackets







*Stainless steel window frames, chandelier, and rails are both decorative and practical.*

*This door panel indicates how cast stainless steel can be used with artistic effect.*

*Stainless steel yacht fittings resist salt water corrosion and are strong and enduring.*





Gasoline and oil tanks  
Propellers  
Shafts  
Pump parts

## ARCHITECTURAL USES

As in the marine and shipbuilding fields, stainless steels are used by architects and builders for increased utility and lasting beauty. The corrosion-resistant properties of these steels make them invaluable for use where a permanent, gleaming, silvery finish is desired. In large cities smoke, dirt, and gases in the air slowly corrode the exterior trim of buildings. The permanence and beauty of stainless steels have led to their extensive use as trim of such well-known edifices as the Empire State Building and the Chrysler Tower in New York, and the LaSalle-Wacker Building in Chicago.

The popular demand for household appliances that can readily be kept spic-and-span has resulted in a demand for stainless steel furnishings in homes and public buildings. The accompanying list is typical of the applications found in the structural and decorative fields:

Exterior building trim:

Window sash, spandrels, mullions, towers, balconies, grilles, screens, etc.

Interior trim:

Elevator lobbies, vestibules, hand rails  
Overmantles, ceilings, and window curtains  
Bank cages and fixtures  
Vault linings and safe deposit boxes and doors  
Mirror frames, nameplates, etc.

Household equipment:

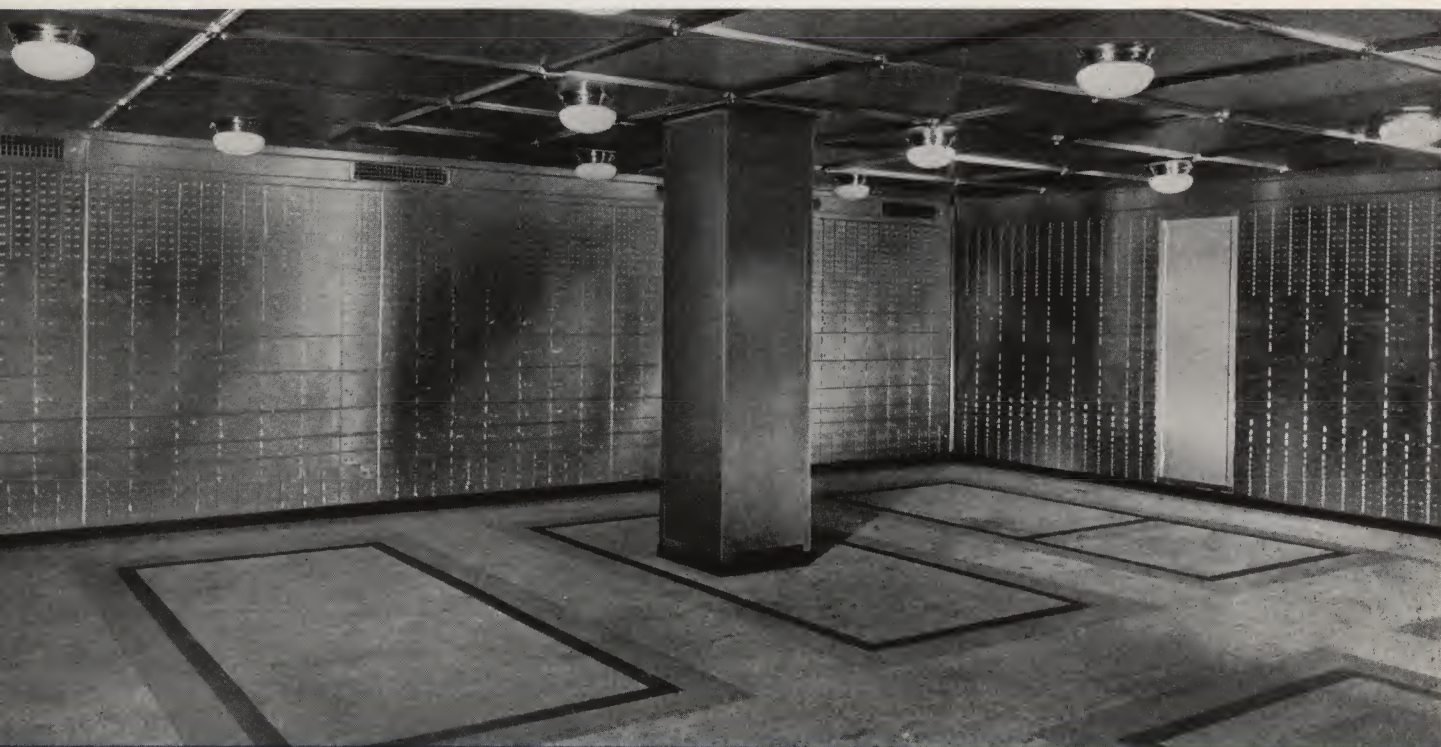
Boilers  
Cooking utensils  
Cutlery  
Table tops, sinks, and refrigerators  
Wainscoting  
Plumbing fixtures  
Trim for kitchen ranges  
Tables and chairs  
Lamps and clocks  
Fireplaces and fire screens  
Hardware of all types

Structural:

Wire rope  
U-bolts for underwater construction  
Covered bridges

Hydraulic construction

*The safe deposit boxes, columns, and trim of this modern bank are beautified with sheets of straight-chromium steel.*







*High-speed trains, fabricated of stainless steel, combine beauty and speed with safety and economy.*

#### RAILROAD EQUIPMENT

The use of stainless steel in the railroad industry is not new. In the last few years, however, has come a much more complete utilization of this modern metal. The present trend in passenger transportation is toward high-speed, streamlined trains. These are especially suited for fast runs, both in shuttle service and long distance runs, such as from Chicago to Los Angeles.

These lightweight trains have indeed utilized the full advantages of stainless steel. Contrary to most metals, which become less ductile at low temperatures, stainless steel retains its toughness. Structural members made of welded stainless steel sheet have shown their practicability in service, and sections weighing only 1.77 lb. per linear foot have tested 70,000 lb. per sq. in. compression strength. Rolling stock built up from these structural members is sheathed with thin corrugated sheets of stainless steel. The result is a strong streamlined car that needs no painting to be made corrosion-resistant and beautiful. Quantities of the same metal are also used in the fitting of the trains, which makes for trains of exceptional

speed and lightness combined with durability and economy of locomotion.

The high creep strength and resistance to oxidation of stainless steels at elevated temperatures renders them suitable for use in locomotive firebox side sheets, condenser tubes, arch supports, and superheater parts. In addition to the tank cars already mentioned under the dairy and chemical industries, stainless steels are well adapted for trim and utensils in dining cars, and plumbing fixtures on Pullman cars and passenger coaches.

*This two-seater monoplane is a sturdy stainless steel craft built for training pilots.*







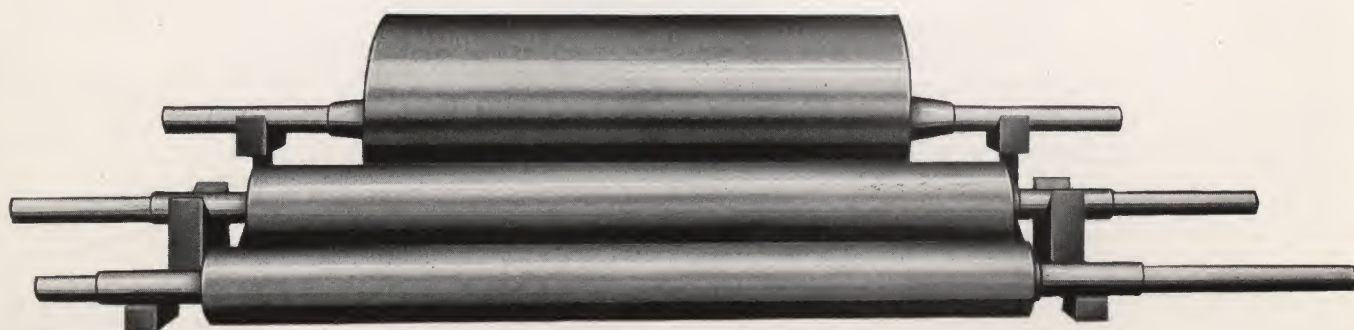
*Here, complete with tailpipe assembly, is a stainless steel exhaust system for a fighter plane.*

### AIRCRAFT INDUSTRY

Success of stainless steels in the railroad industry has been matched by their utilization and success in airplanes. At first these steels were used for only a few special parts, but now their use is widely extended. Thin structural sections that are used in airplanes must necessarily be protected from corrosion—not only to prolong the life of the plane but also to eliminate a distinct element of danger. Parts made of stainless steel are stronger

and do not corrode, and they are consequently much safer. Stainless steel is extensively used for wing structures, nacelles, cowling, exhaust and supercharger systems, and firewalls. Important aircraft accessories are also made of stainless steel, such as heat-exchangers, filters, heaters, oxygen tanks, fuel and oil tanks, cartridge starters, and carburetors. Other important applications are impellers, flexible hose, hose clamps, hinge pins, washers, nuts, and screws.

*Stainless steel helps to solve many problems in the dyeing industry. These rolls are of 18-8 chrome-nickel steel.*





### DYEING INDUSTRY

Stainless steel may be used to advantage for equipment in the dyeing industry because it offers all the advantages of materials formerly used without any of their disadvantages. Wooden vats, which have been largely used in the past in dyeing operations, have two distinct disadvantages: (1) prolonged boiling-out operations are necessary when it is desired to change from one color to another, and (2) splinters frequently cause damage when delicate fabrics are being treated. For these reasons wooden vats may in many cases be replaced to advantage by stainless steel vats.

Experience has shown that stainless steel is an ideal material for this application. When changing dyeing solutions from one shade to another, it is necessary only to drain out the vats and rinse them with a stream of water from a hose. The time required to change from one color to another is so much less when stainless steel vats are used that in some cases one vat has replaced ten or even fifteen wood vats. Stainless steel is being used to advantage for the following dye-house equipment:

- Vats
- Pumps, valves and piping
- Reels and rolls
- Agitators
- Spray pipes
- Buckets and dippers
- Dye sticks
- Yarn tubes and racks

### BREWING INDUSTRY

Many materials have been used for the construction of vessels used in the brewing industry, but many of them possess some very definite disadvantages. Some are difficult to fabricate, others are hard to keep clean, while others cause a "haziness" or turbidity in the beer. Some of the metals impart an undesirable flavor to the beer; some are easily attacked by the chemical cleansing agents used; while others adversely affect the fermentation process.

Stainless steel has been shown, both by laboratory tests and by actual use in breweries, to be an ideal material for brewing equipment. It does not affect the flavor, color, brilliancy, or fullness of the beer; nor does the beer attack stainless steel. The

following list includes various applications of stainless steel in the brewing industry:

- Yeast pans
- Fermentation vats
- Storage and auxiliary tanks
- Cooling coils
- Siphons
- Measuring vessels
- Clarifier slats
- Filters
- Heat exchangers
- Bottling machinery
- Beer barrels
- Wort coolers

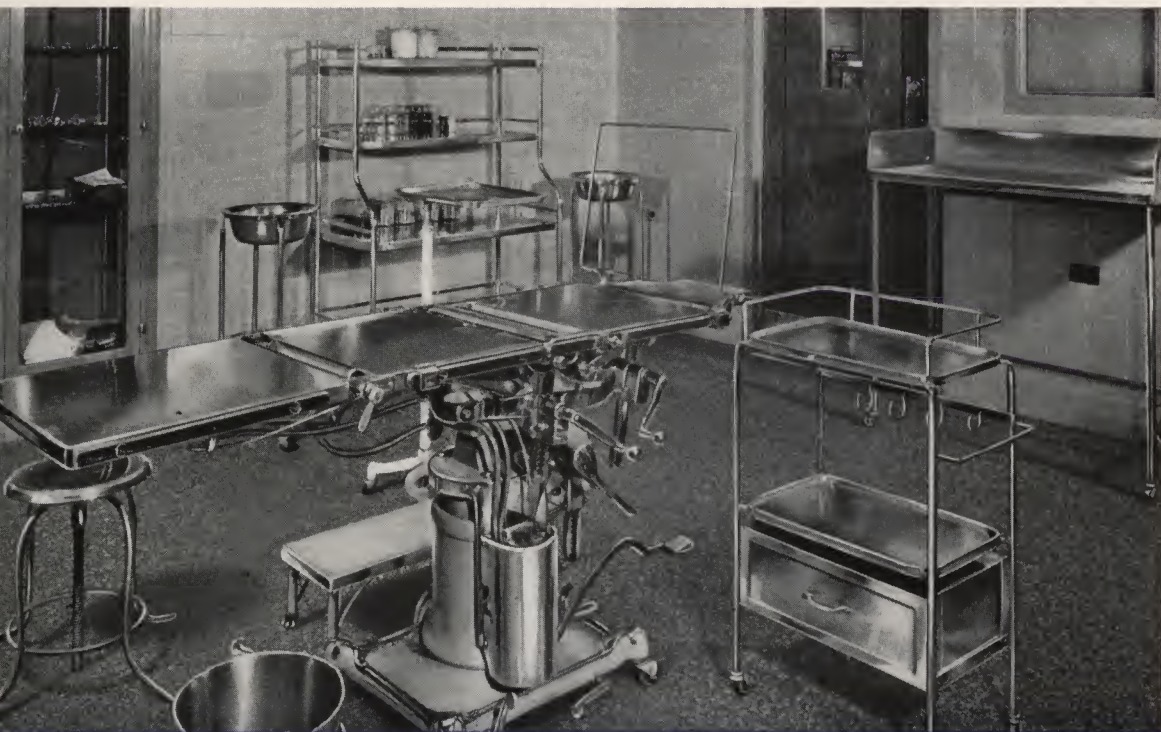
### OTHER APPLICATIONS

Practically every industry has some equipment in which the use of stainless steels would prove of value. To cover these applications in complete detail would be impossible. The following list con-

*Here are several stainless steel clad-lined tanks, with a sanitary finish, installed in a large midwestern brewery.*







*Hospital operating rooms are equipped with stainless steel for cleanliness, convenience, appearance, and permanence.*

sists of typical examples taken from the fields not already covered:

## Hospitals:

- Pans for X-ray tables
- Sun lamp reflectors
- Oxygen room and tent fixtures and parts
- Baby incubators
- Humidifiers
- Operating-room equipment
- Kitchen equipment
- Instruments

## Paper mills:

- Blowpit bottoms
- Relief gas lines and coolers
- Acid circulation systems
- Digestor linings
- Corrosion-resisting wire and wire rope
- Steam turbine blades
- Motion-picture film developers
- Blueprint machines
- Tanks for zinc plate etchings
- Clamps for phone directory stands

Manhole steps for sewers

Street lane and traffic markers

Caps for surveyor's bench marks

Screws, bolts, and nuts of all kinds

Laundry equipment

Barber shop and beauty parlor appliances

Soap manufacturing equipment

Dentures

Dental instruments

Jewelry:

- Watches, settings, vanities, cigarette cases, etc.

Laboratory apparatus

Trunk corners and trim

Golf clubs

The examples herein mentioned are but a few of the many ways in which stainless steel may be used beneficially. Since the manufacture and fabrication of stainless steels have been placed on a commercial basis, new applications are being constantly found, and the development and expansion of their use have been truly remarkable.



*The highly polished surface of this stainless steel turntable helps to assure absolute cleanliness in the manufacture of the drug penicillin.*



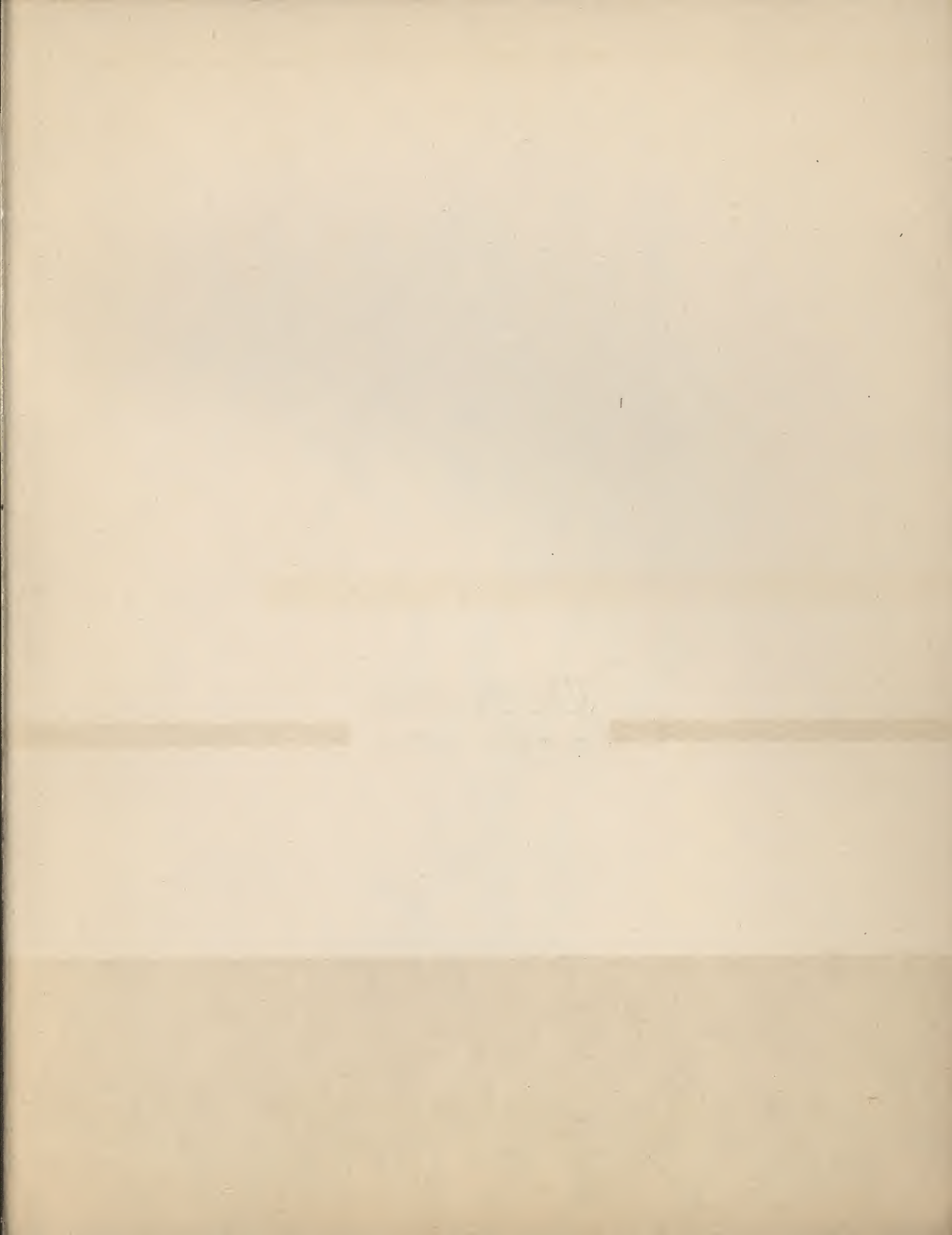
*Here are some stainless steel kettles in a silver-nitrating room, where photographic and motion-picture materials are made.*













# **Electromet**

Trade-Mark

## **Ferro-Alloys & Metals**